

Patent Claims

1. 1. Polymorphic forms of (+)-(S)-Clopidogrel-hydrogen-bromide, which are named herein as polymorphic "Form A", polymorphic "Form B", polymorphic "Form C", polymorphic "Form D", polymorphic "Form E", and as polymorphic "Form F", and which differ from each other in their powder-roentgen-diagrams (XRPD), according to the characteristic peaks as listed in Table 1, given in degree  $2\theta$  with an exactness of  $\pm 0.2$  Grad  $2\theta$ :

Table 1

Clopidogrel hydrobromide Form	Angle [ $2\theta^\circ$ ]:	Relative intensity
A	9.83	medium
	10.35	medium
	19.98	strong
	23.03	strong
B	9.49	medium
	10.39	medium
	12.87	medium
	19.53	strong
C	8.20	strong
	8.92	strong
D	9.76	medium
	10.40	weak-medium
	19.50	strong
	23.01	strong
E	7.72	medium
	9.27	medium
	9.88	medium
	11.91	medium
F	12.48	strong
	15.89	medium
	20.16	strong
	21.97	strong

2. Polymorphic forms of (+)-(S)-Clopidogrel-napsylate, which are named herein as polymorphic "Form A" and polymorphic "Form B" and which differ from each other in their powder-roentgen-diagrams (XRPD), according to the characteristic peaks as listed in Table 2, given in degree  $2\theta$  with an exactness of  $\pm 0.2$  Grad  $2\theta$ :

Table 2

Clopidogrel napsylate Form	Angle [ $2\theta^\circ$ ]:	Relative intensity
A	8.59	medium-strong
	13.55	medium-strong
	19.00	medium-strong
	21.34	strong
B	7.67	medium
	8.41	strong
	9.05	medium
	10.00	medium

10

3. Method of making Clopidogrel hydrobromide of Form A according to claim 1, characterized in that Clopidogrel hydrobromide of any crystalline form is crystallized from a solvent or a mixture of solvents, comprising acetone, acetic acid ethyl ester, diisopropylether, tert.-butyl-methylether, methyl-isobutylketone, dichloromethane, toluene, isobutyronitrile, and/or isopropanol, preferably methyl-isobutylketone and/or isopropanol, preferably in a weight ratio of 4:1, within a temperature range of  $18^\circ\text{C}$  to  $22^\circ\text{C}$ .

20

4. Method of making Clopidogrel hydrobromide of Form B according to claim 1, characterized in that Clopidogrel hydrobromide of any crystalline form is crystallized from a suitable solvent, preferably acetone and/or dichloromethane, by quickly crossing the saturation curve, preferably by quick addition of an antisolvent, preferably of an aliphatic hydrocarbon, preferably heptane and/or hexane, or by evapo-

25

ration crystallization, or by very quick cooling of the crystallization solution (shock cooling).

5. Method of making Clopidogrel hydrobromide of Form C  
5 according to claim 1, characterized in that Clopidogrel hydrobromide of any crystalline Form is crystallized from acetonitrile.

6. Method of making Clopidogrel hydrobromide of Form D  
10 according to claim 1, characterized in that Clopidogrel hydrobromide of any crystalline Form is crystallized from a solvent or a mixture of solvents, comprising acetone, acetic acid ethyl ester, diisopropylether, tert.-butyl-methylether, methyl-isobutylketone, dichloromethane, toluene, isobutyro-  
15 nitrile and/or isopropanol, preferably methyl-isobutylketone and/or isopropanol, preferably in a weight ratio of 4:1, within a temperature range from 30°C to 60°C.

7. Method of making Clopidogrel hydrobromide of Form E  
20 according to claim 1, characterized in that Clopidogrel hydrobromide of any crystalline Form is crystallized from dichloromethane and/or an aliphatic hydrocarbon with a boiling point of preferably 60°C to 125°C, preferably hexane, heptane or octane, preferably within a temperature  
25 range from 0°C to 25°C, or by crystallization by slow evaporation of the lower boiling solvent from the solvent mixture at temperatures within the temperature range of 0°C to 25°C, preferably at long crystallization times of up to 24 hours.

30 8. Method of making of Clopidogrel hydrobromide of Form F according to claim 1, characterized in that Clopidogrel hydrobromide of any crystalline Form is crystallized from a solvent or a mixture of solvents, comprising acetone, acetic acid ethyl ester, diisopropylether, tert.-butyl-methylether,  
35 methyl-isobutylketone, dichloromethane, toluene, isobutyro-

nitrile and/or isopropanol, preferably methyl-isobutylketone and/or isopropanol, preferably in a weight ratio of 4:1, within a temperature range of -5°C to +15°C.

5

9. The salts Clopidogrel besylate, Clopidogrel tosylate and Clopidogrel oxalate.

10

10. Method of making Clopidogrel besylate according to claim 9, characterized in that equimolar amounts of benzenesulfonic acid and Clopidogrel base are combined in a suitable solvent to react together, preferably in an alcohol, ether and/or nitrile, preferably in methanol, whereby the compound is preferably isolated by solvent abstraction, preferably by removing the solvent by distillation or by spray drying.

20

11. Method for making Clopidogrel tosylate according to claim 9, characterized in that equimolar amounts of paratoluenesulfonic acid are combined with Clopidogrel base in a suitable solvent to react together, preferably in an alcohol, ether and/or nitrile, preferably in methanol, preferably at a working temperature of 20-25°C, whereby the compound is preferably isolated by solvent abstraction.

25

12. Method of making Clopidogrel oxalate according to claim 9, characterized in that equimolar amounts of oxalic acid are reacted with Clopidogrel base in a suitable solvent, preferably in an alcohol, ether, a nitrile, and/or an aqueous solvent mixtures thereof, preferably in isopropanol and/or diisopropylether and aqueous solvent mixtures, preferably thereof, with a water content of preferably less than 10% by weight of water (<10% by weight), whereby the compound is isolated by solvent abstraction.

35

13. Method of making Clopidogrel napsylate Form A according to claim 2, characterized in that equimolar amounts of naphthalene-2-sulfonic acid are combined with Clopidogrel base in a suitable solvent and initiating crystallization by  
5 inoculating the crystallization solution with Clopidogrel napsylate Form A, preferably in primary and/or secondary alcohols, ethers, nitriles, toluene and aqueous solvent mixtures, preferably thereof, with a water content of preferably less than 10% by weight (<10% by weight),  
10 preferably at a temperature working range between 20°C and 60°C, preferably in isopropanol-water mixtures, diisopropylether, preferred is isopropanol-water mixtures.

14. Method of making Clopidogrel napsylate Form A according to claim 2, characterized in that said Clopidogrel napsylate  
15 Form A is made from another Clopidogrel salt by salt transformation in the presence of naphthalene-2-sulfonic acid salts, preferably sodium-2-naphthylsulfonate, preferably from Clopidogrel hydrobromide, preferably in isopropanol,  
20 diisopropylether, and/or aqueous solvent mixtures, preferably thereof, with a water content of preferably less than 10% by weight of water preferably at a working temperature range of 20°C to 60°C.

25 15. Method of making Clopidogrel napsylate Form A according to claim 2, characterized in that said Clopidogrel napsylate Form A is obtained directly and without inoculation, by reacting equimolar amounts of naphthalene-2-sulfonic acid with Clopidogrel base in a suitable solvent, preferably in  
30 isopropanol, diisopropylether, and/or aqueous solvent mixtures, preferably thereof, with a water content of preferably less than 10% by weight wherein said naphthalene-2-sulfonic acid has a purity of at least 99.5 % by weight and preferably, wherein the content of naphthalene-1-  
35 sulfonic acid is less than 0.5% by weight.

16. Method of making Clopidogrel napsylate Form B according to claim 2, characterized in that equimolar amounts of naphthalene-2-sulfonic acid are dissolved with Clopidogrel  
5 base in a suitable solvent and crystallization is initiated by inoculation with Clopidogrel napsylate Form B, preferably in a primary and/or secondary alcohol, a nitrile, toluene and/or an aqueous solvent mixture, preferably thereof, with a water content of preferably less than 10% by weight of  
10 water, preferably in isopropanol as a solvent, preferably in a strongly over saturated crystallizing solution (>20%), at a temperature working range from 15°C to 20°C.

17. Method of making Clopidogrel napsylate Form B according to claim 2, characterized in that said Clopidogrel napsylate  
15 Form B is obtained by salt transformation from another Clopidogrel salt, preferably Clopidogrel hydrobromide, in the presence of a naphthalene-2-sulfonic acid salt, preferably sodium-2-naphthylsulfonate, or by recrystallization  
20 from Clopidogrel napsylate Form A, by inoculating the solution with the Clopidogrel napsylate Form B, preferably in isopropanol and/or diisopropylether, and aqueous solvent mixtures, preferably thereof, with a water content of preferably less than 10% by weight (<10% by weight) of water,  
25 preferably at a temperature working range of 15°C to 20°C.

18. Method of making Clopidogrel napsylate Form B according to claim 2, characterized in that said Clopidogrel napsylate Form B is obtained directly without inoculation by reacting  
30 equimolar amounts of naphthalene-2-sulfonic acid with Clopidogrel base in a suitable solvent, preferably isopropanol and/or diisopropylether, and/or aqueous solvent mixtures, preferably thereof, with a water content of preferably less than 10% by weight of water, wherein the naphthalene-2-  
35 sulfonic acid used has a purity of less than 99.0% by weight

and preferably if its content of naphthalene-1-sulfonic acid is higher than 1.0% by weight.

19. Pharmaceutically active compositions which contain at  
5 least one compound according to any one of the claims 1, 2  
and 9 in a pharmaceutically effective concentration.

20. Use of the compounds according to any one of the claims  
1, 2 and 9 for the preparation of pharmaceutically active  
10 compositions which contain at least one of said compounds in  
a pharmaceutically effective concentration.

Summary

Polymorphic forms of (+)-(S)-Clopidogrel-hydrogen bromide  
5 named polymorphic "Form A", polymorphic "Form B",  
polymorphic "Form C", polymorphic "Form D", polymorphic  
"Form E", and as polymorphic "Form F", and polymorphic forms  
of (+)-(S)-Clopidogrel-napsylate, named polymorphic "Form A"  
and polymorphic "Form B" and which differ from each other in  
10 their powder-roentgen-diagrams (XRPD); as well as the salts  
Clopidogrel besylate, Clopidogrel tosylate and Clopidogrel  
oxalate and methods for making these compounds.